1. Introduction

This document provides technical guidance to surface finishers, environmental managers and decision makers on control technologies and process changes for approaching zero discharge (AZD). AZD is one of the key themes underlying the Strategic Goals Program (SGP), a cooperative effort among the U.S. Environmental Protection Agency (EPA), the American Electroplaters and Surface Finishers Society, the National Association of Metal Finishers, and the Metal Finishing Suppliers Association to test and promote innovative ideas for improved environmental management within the metal finishing industry. For more information on this program, see *http://www.strategicgoals.org/*

In its broadest sense, "zero discharge" means no discharge to any media. More commonly, zero discharge focuses on zero wastewater discharge. This report presents information and strategies for approaching zero discharge for concentrated process fluids and associated rinsewaters from surface finishing manufacturing. This focus is intended to minimize discharges of spent and/or underused process fluids. Specific SGP goals addressed in this report are:

- Improved use of process chemistry (SGP goal is 98% metals utilization on product);
- Water use reduction (SGP goal is 50% reduction); and
- Hazardous waste emissions reduction (SGP goal is 50% reduction in metals emissions to air and water, and 50% reduction in hazardous waste sludge disposal).

The following list provides a section-by-section overview of this report:

Section 2: Systematic AZD Planning
This section and related Appendix A provide key considerations for planning through implementation of any AZD project. Without systematic planning and appropriate implementation, an AZD project can fail or fall short of overall potential. The techniques and technologies presented in Sections 3 through 6 should be pursued within a systematic framework. Specific approaches within these general categories may be used independently or in combination to meet specific AZD goals.

Section 3: Process Solution Purification and Recovery Technologies
This section presents technologies for in-plant purification and maintenance of surface finishing process solutions and rinses. Pursuing this approach results in reduced discharges through improved use of process solutions.

Section 4: Rinse Purification or Concentrate Recovery Technologies
This section presents technologies for purification of rinses for recycling to surface finishing processes. Pursuing this approach can result in a combination of improved use of process solutions and water.

Section 5: Alternative Surface Finishing Processes and Coatings
Section 5 advances alternative surface finishing processes and coatings. Most of the alternative surface finishing processes and coatings can result in substantial reductions in discharges compared to traditional processes.

Section 6: Improving Existing Process Conditions and Practices
This section presents techniques for modifying existing process operations and plant practices. Reduced discharges can result in modifications that provide for better process optimization.

Section 7: Conclusions

Section 8: References

Appendix A: Systematic Approach for Developing AZD Alternatives
This is a supplement to Section 2 that presents a systematic method to guide the identification, development, and implementation of AZD actions.

Appendix B: Installed Costs
This appendix provides installed cost information.

Table 1-1 provides a topical section cross reference.

Table 1-1 Section/Topic References from Section 8

Section	Topic	References
Section 2	Systematic AZD Planning	9, 14,15
Section 3	Process Solution Purification and Recovery Technologies	
	• Ion Exchange	2, 3, 4, 5, 6, 7, 9, 10
	• Reverse Osmosis	2, 3, 4, 5, 6, 9
	• Vacuum Evaporation	2,3,4,5,7
	• Atmospheric Evaporation	3, 4, 6, 7, 9, 17
	• Electrodeionization	5
	• Electrodialysis	3, 4, 5, 9, 17
	• Electrowinning	3, 6, 9
	• Nanofiltration	5, 9
	• Polymer Filtration	4, 5
	• Ultrafiltration	**3,** 4, 5, 6, 9
Section 4	Rinse Purification or Concentrate Recovery Technologies	11, 12, 18
Section 5	Alternative Surface Finishing Processes and Coatings	1, 2, 4, 5, 13, 15, 16, 17, 19
Section 6	Improving Existing Process Conditions and Practices	1,2,9
Section 7	Conclusions	1,6,9
Appendix A	Systematic Engineering Approach	6, 9, 14, 15
Appendix B	Installed Costs	1, 5, 7, 8, 9, 10, 17